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CIMAC Position Paper

On the use of term conventional / unconventional in maritime regulations

The first edition of this CIMAC Guideline / Position Paper was approved by the members of the CIMAC WG21 “Propulsion” at its meeting on November 6th 2024.

Content

1 Preamble

This document discusses the terminology “conventional and unconventional” used in regulatory frameworks. It is important to use these terms carefully, especially when referring to performance requirements or technological solutions.

CIMAC understands that in the global marine industry, there is an assumed consensus on the meanings of “conventional” and “unconventional.” However, these terms are not defined by International Maritime Organization (IMO) documents or international standards. Despite this, performance requirements for certain technologies are directed based on these terms. Therefore, CIMAC believes that the terminology and usability of these terms should be carefully considered.

Other similar but poorly defined terminology includes:

- Conventional - nonconventional
- Traditional - nontraditional
- Novel
- New

It is essential to differentiate the terms conventional/unconventional from proven/unproven and reliable/unreliable, as they are often easily confused. Using conventional technology does not inherently make it proven or reliable. Similarly, unconventional does not mean unproven or unreliable. The methods to validate and estimate the reliability of technology must be goal-based, not terminology-based.

2 Application

This position paper is written from the perspective of ship propulsion systems and arrangements. However, it is important to consider the use of terminologies in other ship systems as well.

3 Purpose

The purpose of this document is to highlight and bring attention to industry concerns regarding the use of terminology, which is not clearly defined. It also proposes an approach to overcome the current challenges.

4 CIMAC analysis

CIMAC Working Group 21 Propulsion analyzed two recent IMO documents, SSE 9/14/4 and MSC 105/18/1, as well as the final report of the EMSA Steering and Maneuverability Study. The purpose of the analysis was to examine how the terms “conventional,” “non-conventional,” “traditional,” “non-traditional,” and “novel” are used. The analysis is summarized in the following chapters.

In addition to the aforementioned terms, SOLAS uses the term “unconventional.”

It can be concluded that while the terminology is widely used, and the terminology is not defined. This makes it impossible for the reader to determine the intended interpretation. Yet, there are several references to rule requirements based on the terminology.

4.1 Analysis of wording in MSC105/18/1 (13 January 2022)

Search term: Conventional / non-conventional (15 hits when searching).

- Conventional arrangements
- Conventional rudders
- Conventional trail manoeuvres
- Conventional steering and propulsion systems
- Conventional designs
- Conventional towing tanks
- Conventional ship form
- Conventional Auto Pilot
- Conventional compass
- Conventional similar zig-zags
- Non-conventional steering and propulsion systems

Search term: Traditional / Non-traditional (12 hits when searching).

- Traditional propulsion and steering systems
- Traditional and non-traditional propulsion and steering systems
- Traditional system
- Traditional arrangements
- Traditional steering systems with rudder

Search term: Novel (1 hit).

- Novel types of control actuators

4.2 Analysis of wording in SSE 9/14/4 (21 December 2022)

Search term: Conventional / non-conventional (0 hits when searching).

- Not used

Search term: Traditional / non-traditional (7 hits when searching).

- Traditional arrangements
- Traditional propulsion system
- Traditional and non-traditional propulsion and steering systems
- Non-traditional multiple steering systems
- Non-traditional steering arrangements

- Non-traditional steering systems

4.3 Analysis of wording in EMSA Steering and manoeuvrability study

Search term: Conventional / non-conventional (53 hits when searching).

- Unconventional propulsion
- Conventional steering system = One hydraulically operated rudder
- Conventional systems
- Conventional and non-conventional steering/propulsion arrangements
- The various steering/propulsion systems, both conventional and non-conventional
- Traditional (e.g. shaft driven ships with conventional rudders)
- Conventional rudder-propeller systems
- Conventional (shaft-driven propeller and rudder)
- Conventional systems: This is the most commonly applied system with a shaft-driven propeller and a rudder behind. A schematic overview is shown in Figure 5-1.

Search term: Traditional (20 hits when searching).

- Traditional steering system
- Traditional performance
- Traditional single line system
- “traditional” design
- Traditional arrangements

5 Historical perspective

5.1 From early era to today

From the dawn of civilization, the sea has fascinated humankind. Throughout history, people have sought to navigate the seas with a myriad of ships and crafts. The reasons have varied, but the driving forces have been the search for commerce and the desire to extend frontiers. Ships have developed based on needs, available knowledge, and technology. The earliest propulsion was based on human-operated oars, but humans quickly learned to utilize sails to harness wind power. The reign of sails lasted for thousands of years until the invention of steam power. Meanwhile, oars evolved into steering oars, and later into rudders. The invention of the steering wheel to replace the whipstaff remarkably improved the handling of large ships.

After the invention of steam power, it began to replace sails, but the transition was not rapid. Initially, the power of steam engines was limited. During this era, hybrid propulsion systems combining sails and steam engine-operated paddle wheels on the sides of ships were common. Although the paddle wheel is an old invention, it was not a particularly popular propulsion system.

A significant technological advancement was the screw propeller. Positioned at the aft of the ship and connected to an engine, the propeller efficiently transforms the engine's rotational power into thrust. Even today, screw propellers remain the most common propulsion device.

As technology continued to develop, diesel engines started to replace steam engines. This transition was much faster than the shift from sails to steam engines. Today, diesel engines are the most common solution. Recent advancements in diesel technology have focused on developing more environmentally friendly fuels. At the same time, electric propulsion has advanced rapidly.

Today, technological development is rapid and accelerating. Improving efficiency and developing sustainable solutions for the future requires innovative approaches. The trend is towards integrated and hybrid systems, where functional targets can be achieved using various technologies. Therefore, it is important to view ships as systems and develop functional goals rather than categorizing technologies.

5.2 History of SOLAS

The SOLAS (Safety of Life at Sea) Convention was first adopted in 1914 in response to the Titanic disaster. It has been revised several times: in 1929, 1948, 1960, and 1974. The 1974 Convention has been updated and amended on numerous occasions. The current version in force is often referred to as SOLAS 1974, as amended. The amendments adopted by the IMO Maritime Safety Committee (MSC) are listed in MSC resolutions.

The 1914 version did not say much about propulsion systems. It stated:

Article XXII. Going Astern: *Ships shall have sufficient power for going astern to secure proper control of the ship in all circumstances*.

Article XXIII. Auxiliary Steering Apparatus: *Ships shall be provided with an auxiliary steering apparatus, which, however, may be of less power than the main apparatus, and need not be worked by steam or other mechanical power*.

The approach was quite technology neutral. However, it can be concluded that at that time, the common power source was steam, and diesel engines or hydraulic systems were uncommon.

Looking at the latest SOLAS version in force, the original text has changed remarkably little:

Regulation 28.1: *Sufficient power for going astern shall be provided to secure proper control of the ship in all normal circumstances*.

Regulation 29.1: *Unless expressly provided otherwise, every ship shall be provided with a main steering gear and an auxiliary steering gear to the satisfaction of the Administration. The main steering gear and the auxiliary steering gear shall be so arranged that the failure of one of them will not render the other one inoperative*.

What has changed is that SOLAS today includes many references to technical solutions like propellers, rudders, hydraulic pressure systems, internal combustion engines, etc. These reflect the common and state-of-the-art technology in use today. "Conventional" is understood as a technical solution being state-of-the-art at the time SOLAS was implemented. With "unconventional," it is expressed that SOLAS might not be directly applicable and an interpretation for equivalency is needed.

In summary, SOLAS has reflected the common technology of its time but has not been able to fully consider the effects of technological development.

6 Technical Approach

Unconventional propulsion often refers to any propulsion arrangements different from a screw propeller, propeller shaft, optional reduction gear, and internal combustion engine of the 2-stroke or 4-stroke type. Consequently, frequently used propulsion arrangements like diesel-electric propulsion with azimuthing thrusters, among others, have been considered as unconventional propulsion.

Although there are no clear regulatory or other definitions for conventional propulsion, it is commonly understood that today's conventional propulsion arrangement consists of:

- One internal combustion engine connected, if required, with a clutch to the shaft,
- A single shaft with or without a reduction gear,
- One fixed pitch or controllable pitch screw propeller,
- A single rudder that produces lifting force from water flow accelerated by the propeller for ships directional control,
- One hydraulic or electric actuated steering gear to operate the rudder.
- Redundant auxiliary systems for the above mentioned essential components.

This kind of propulsion arrangement is very common in cargo ships, whereas azimuthing thrusters are common in other ship types such as tugs, offshore ships, icebreakers, and large cruise ships. The modern azimuthing thruster using the Z-drive transmission was invented in 1951. Over the last 10 years, an average of 100 to 200 vessels per year with a deadweight or Gross Tonnage above 2000 and azimuthing propulsion have been delivered. Thus, azimuthing thrusters can also be described as conventional propulsion. Arrangements including turbines (steam and gas), waterjets, or cyclorotors have all been used in significant numbers in various configurations and vessel types.

While the definitions of conventional and unconventional propulsion might apply well to certain regulations, they are not applicable measures to evaluate technology maturity or reliability. Furthermore, these definitions neither indicate whether a technology or arrangement is proven or unproven, nor whether it is novel technology or not, nor the reliability level of single technologies or the total system.

Many layouts labelled as unconventional have become standard proven designs, both in years of operation and in the number of installations. Each of these technologies must be ranked on their own merits rather than by the conventional or unconventional label, which is neither based on reliability nor maturity of the technology or any other objective criterion.

7 CIMAC proposal

A neutral terminology is needed, which covers a group of specific technological solutions. Using this neutral terminology enables us to concentrate on goal-based standards, which can be defined to require an equivalent risk level for each of the solutions. The considered purpose of the investigated papers is, to require a reliable ship operation with sufficient steering, propulsion ahead and astern (stopping). Having that in mind, we can find neutral terminology by using "non-steerable propulsor" and "thruster". "Non-steerable propulsor" covers all technologies, where propulsion thrust and steering force are produced by independent means. "Thruster" incorporates both means

– steering and propulsion – into one unit. It is impossible to steer the ship safely if no propulsion thrust is produced.

This definition works fine, even for a pure sailing ship: It belongs to “non-steerable propulsor” because thrust is produced by sails and steering force by an independent rudder, which works even when the ship is only towed. A waterjet drive belongs to “thruster”, even the steering nozzles can be moved independently from the pump unit, but their steering force depends completely on the accelerated jet.

Having made this kind of definition, we can now concentrate on the formulation of requirements, which enable an acceptable level of risk for the ship operation. How this level is obtained by the different technologies needs to be accessed and demonstrated.

Especially nowadays, when Carbon Intensity Indicator (CII) drives to retrofits with additional sails, or fuel cells feeding an additional thruster, the number of hybrid solutions and combinations of very different technologies will increase rapidly. It is high time to prepare for that kind of diversity and colourful future and go for goal-based requirements and risk/equivalency considerations rather than implementing new interpretations of old rules to cover all kind of technologies on the marked or a combination of completely different ones.

For all, including novel technologies, there must be a defined risk assessment ensuring that the whole propulsion and navigation arrangement demonstrates sufficient reliability and technological maturity to be qualified for single essential propulsion.

To address this situation, amendments to SOLAS should focus on formulating goal-based requirements and acceptable risk levels that cover not only the current state of the art but also future technical solutions without the need for interpretation. Depending on the purpose of other rule requirements, a more detailed definition may be necessary and can be provided. But for the time being the above categorization should be used and its applicability throughout requirements for ships to be checked.

8 Summary

Here are the key points from the document:

- Challenges in Definitions: The paper discusses the difficulties in defining technologies and shows the variety of different wording in essential documents applicable to propulsion and steering of ships. There is no clear definition for “conventional”, “traditional” etc., even they are used frequently in IMO and EMSA papers.
- Changing Definitions: It highlights that popular wording can mislead and imply a wrong interpretation, which makes a neutral wording and clear definition necessary. It discusses that definitions are not static and can evolve over time.
- Proposal for Rule Requirements: The paper proposes that the maturity of propulsion arrangements should not be based on whether they are conventional or unconventional. Furthermore, it is proposed that the function of a specific component implies a certain (e.g. acceptable) risk. Solutions for propulsion steering can now be grouped according to their realization of function and can be evaluated based on the accompanying risk.
- Simplified Definitions: It suggests using a grouping along the realization of functions and definitions that work for all kind of propulsion arrangements.

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